Magnetic Field Reconstruction in a Solar Active Region

H. N. Wang et al.
Beijing Astronomical Observatory

It is widely believed that coronal structures delineate magnetic field lines anchored on the photospheric surface. Supposing coronal magnetic fields are in a force-free state from the chromosphere to the height of two solar radii, we reconstruct 3D force-free magnetic fields by making use of a new numerical technique, in which the fields are represented by a boundary integral equation based on a specific Green's function. Vector magnetic fields observed on the photospheric surface can be taken as the boundary conditions of this equation. In this numerical computation, the following two points are emphasized: (1) A new method for data reduction is proposed, for removing uncertainties in boundary data and determining the parameter in this Green's function, which is important for solving the boundary integral equation. In this method, the transverse components of the observed boundary field are calibrated with a linear force-free field model without changing their azimuth. (2) The computed 3-D fields satisfy the divergence-free and force-free conditions with high precision. The alignment of these field lines are in agreement with structures in H_α and Yohkoh soft X-ray images. Since the boundary data are calibrated with a linear force-free field model, the computed 3D magnetic filed can be regarded as a quasi-linear force-free field approximation. The reconstruction of 3D magnetic field in active region NOAA 7321 was taken as an example to quantitatively exhibit the capability of our new numerical technique.